Important Internet Addresses

http://www.zen22142.zen.co.uk/Circuits/cctindex.html

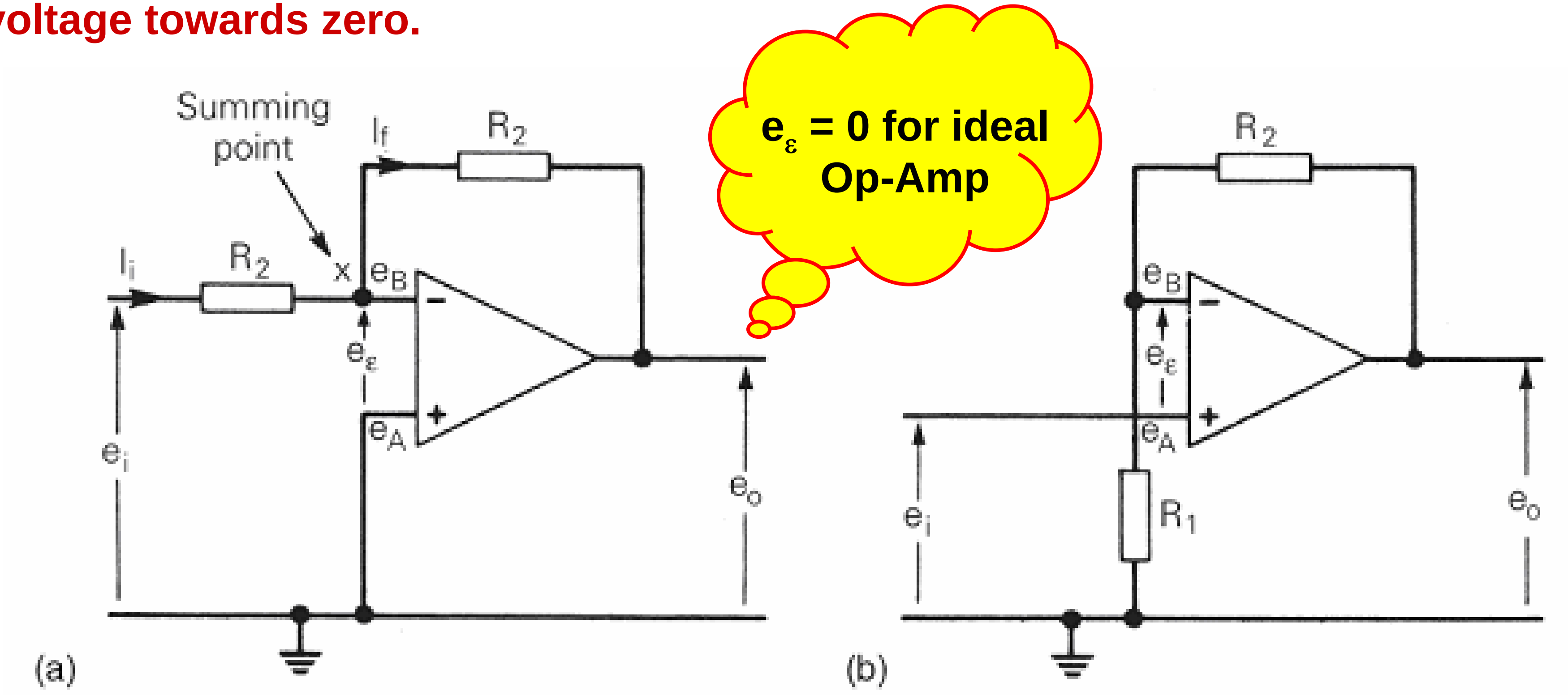
http://www.uoguelph.ca/~antoon/circ/circuits.htm

http://www.nekhely.com/home-new.htm

http://www.maamoon.com/Maamoon/index.asp

Feedback and the Ideal Op-Amp (1)

The signal fed back will be in opposition to e_ε, so forcing the differential input voltage towards zero.



Two basic feedback circuits; (a) Inverting amplifier; (b) Non-inverting amplifier

Feedback and the Ideal Op-Amp (2)

Two Important Rules:

1. **When negative feedback is applied to the ideal amplifier, the differential input voltage is zero.**

2. **No current flows into either input terminal of the ideal amplifier.**

The Ideal Op-Amp at Work

- **It is important to distinguish between the voltage gain of the circuit and the open-loop voltage gain of the op-amp:**

- The open-loop voltage gain A of the op-amp is the voltage gain from the two op-amp inputs to the op-amp output.

- Voltage gain is the gain of the whole circuit (including the Op-Amp).

Inverting Amplifier

$e_\varepsilon = 0$

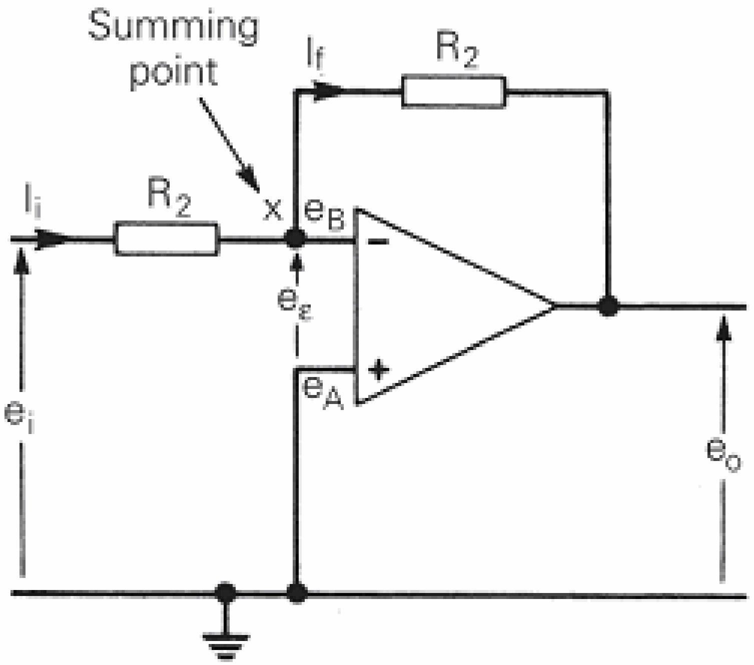
$e_A = e_B = 0$

$$I_i = \frac{(e_i - e_B)}{R_1} = \frac{(e_i - 0)}{R_1}$$

$$I_f = \frac{(e_B - e_o)}{R_2} = \frac{(0 - e_o)}{R_2}$$

$$\therefore \frac{e_i}{R_1} = -\frac{e_o}{R_2}$$

$$\text{Gain} = \frac{e_o}{e_i} = -\frac{R_2}{R_1}$$



(a)

Non-Inverting Amplifier

$e_\varepsilon = 0$

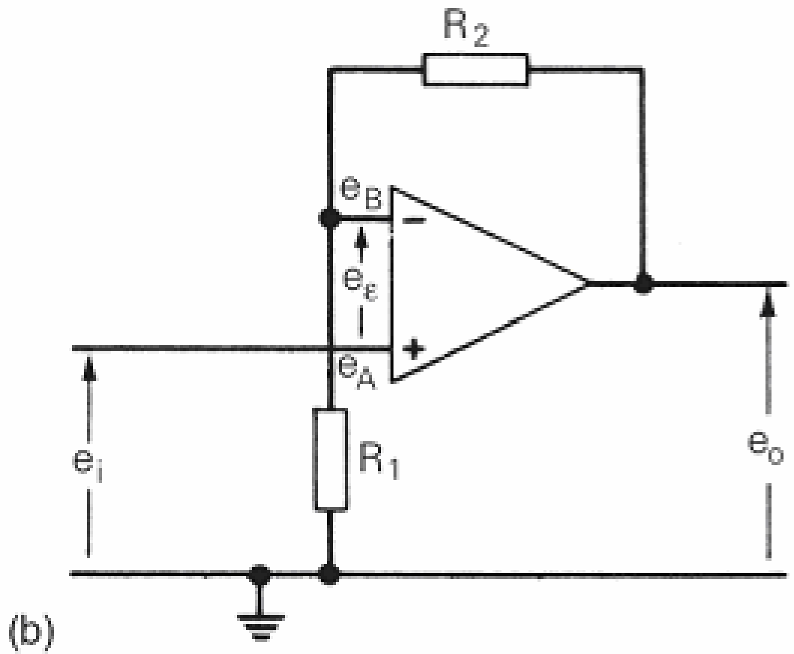
$e_A = e_B = e_i$

$$I_i = \frac{(0 - e_i)}{R_1} = \frac{-e_i}{R_1}$$

$$I_f = \frac{(e_B - e_o)}{R_2} = \frac{(e_i - e_o)}{R_2}$$

$$\therefore \frac{-e_i}{R_1} = \frac{e_i - e_o}{R_2}$$

$$\text{Gain} = \frac{e_o}{e_i} = 1 + \frac{R_2}{R_1}$$

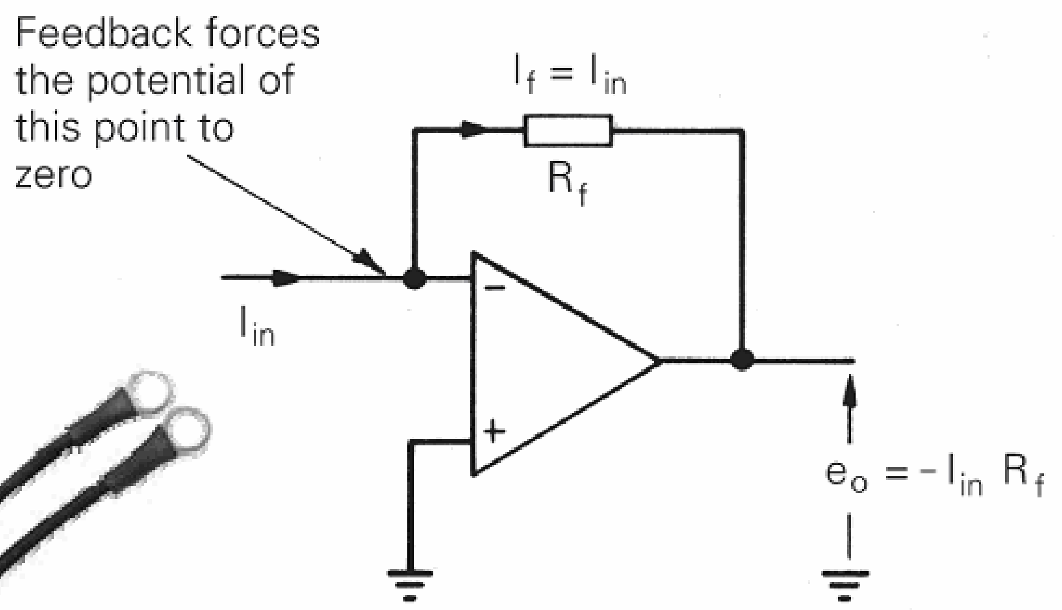


Current-to-Voltage Converter

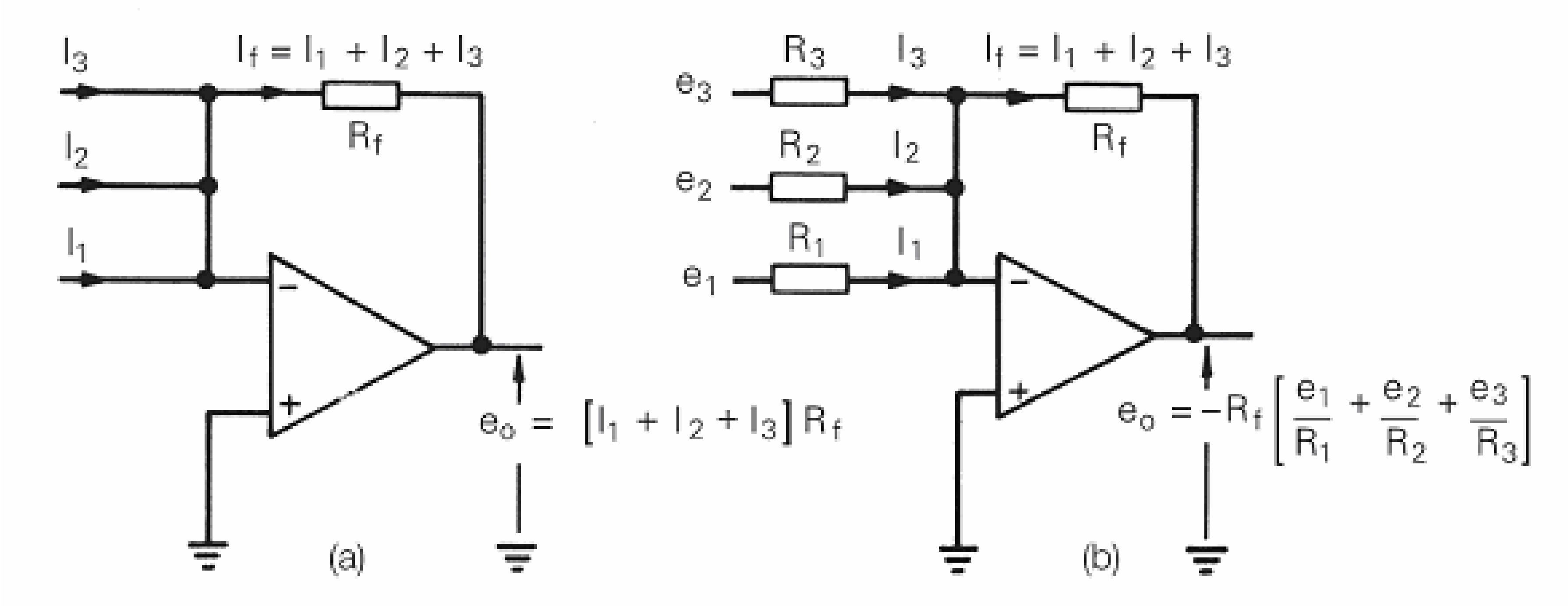
$I_{in} = I_f$

And

$e_o = -I_{in} R_f$

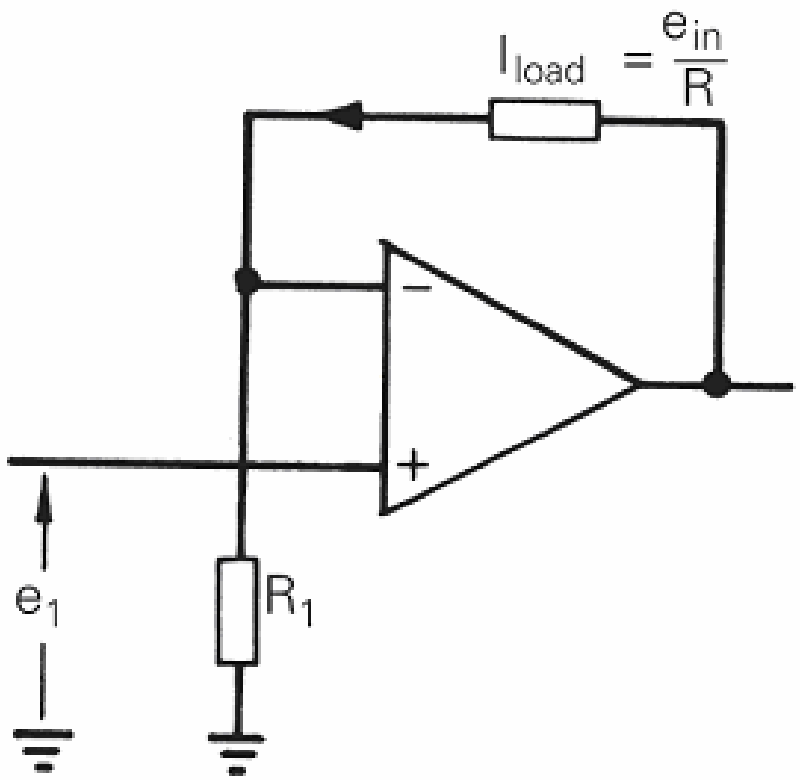


Summing Amplifier



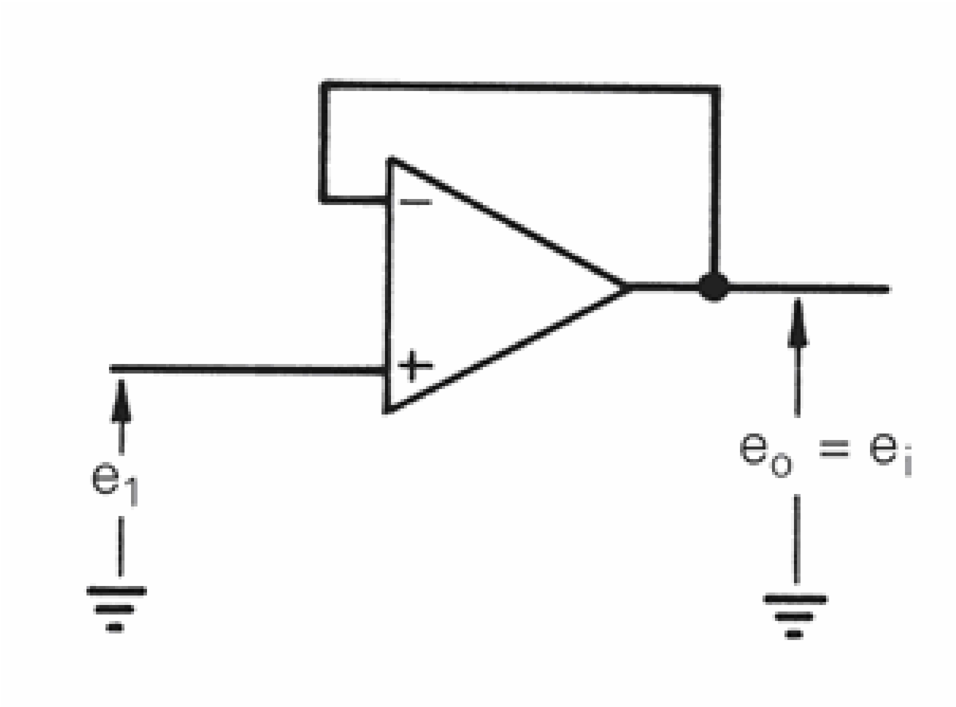
Voltage-to-Current Converter

In maintaining its differential input voltage at zero, the amplifier shown in the circuit forces a current I to flow through the load in the feedback path. The value of this current is independent of the nature or size of the load.

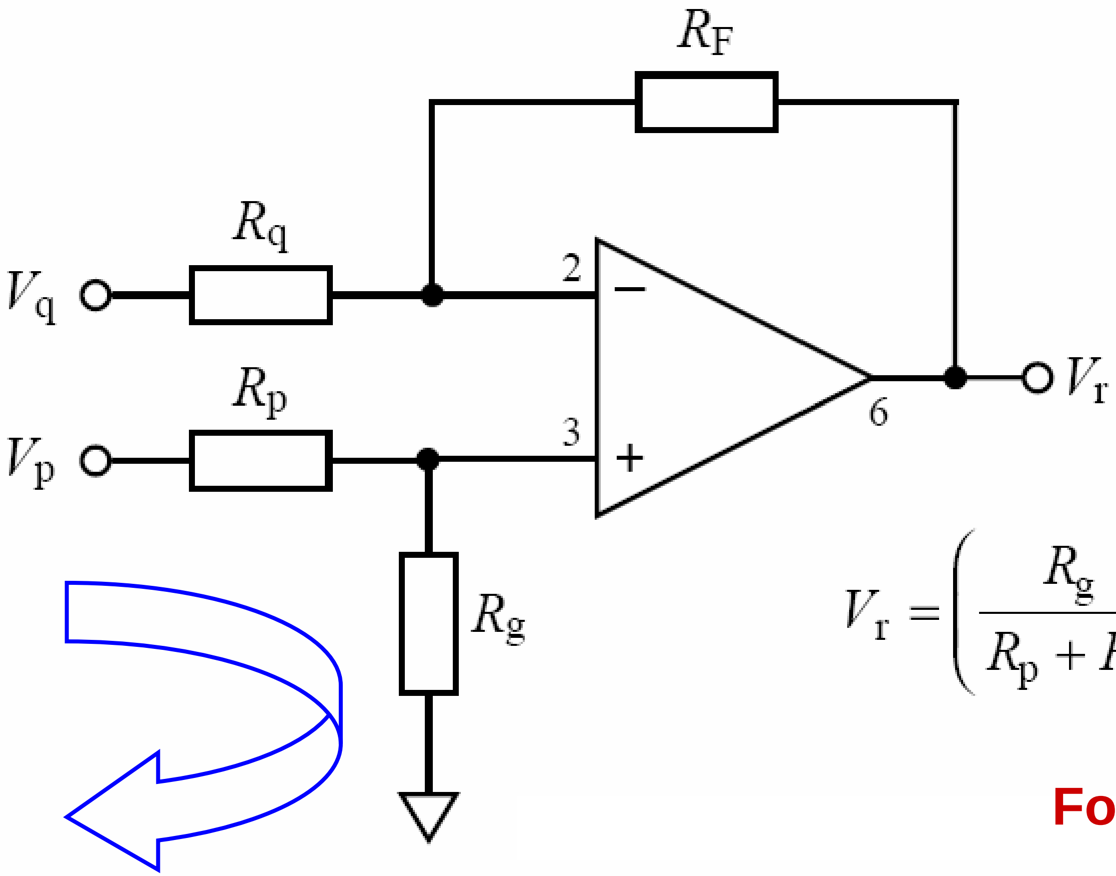


Perfect Buffer (Voltage Follower)

the amplifier output voltage must take on a value equal to the input voltage in order to force the differential input signal to zero. The ideal circuit has infinite input impedance, zero output impedance and unity gain, and acts as an ideal buffer stage.



Subtractor

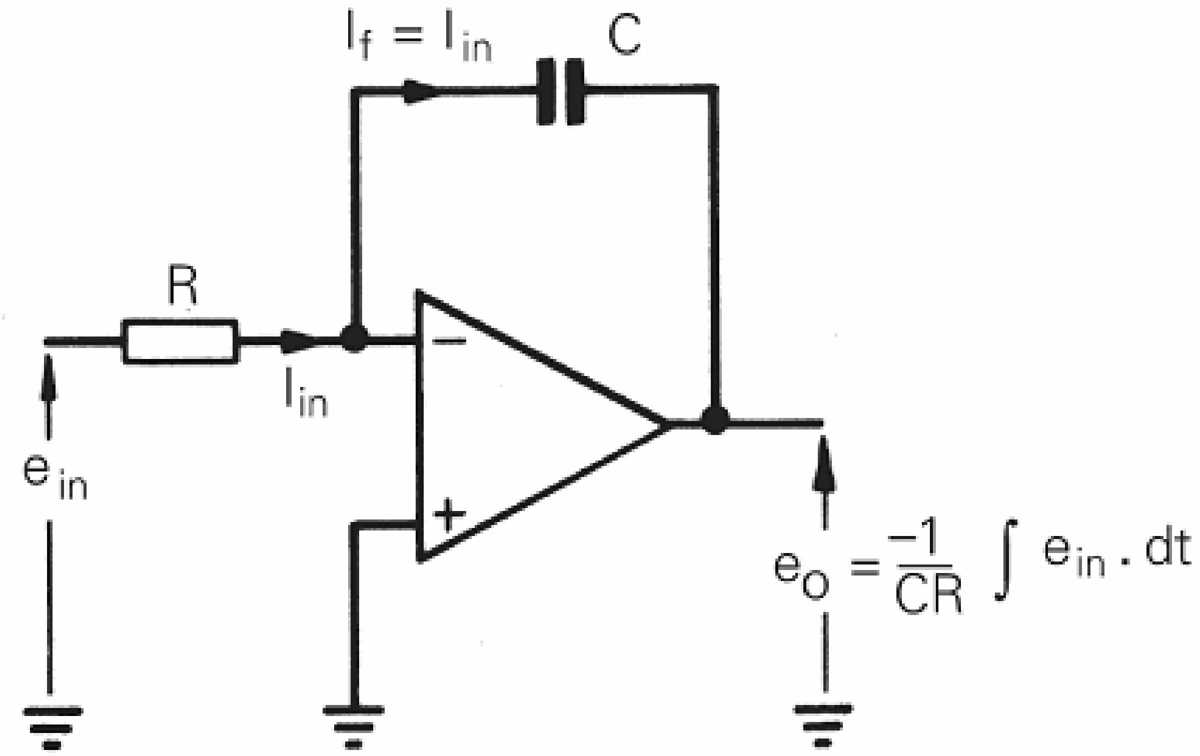


$$V_r = \left(\frac{R_g}{R_p + R_g}\right)\left(1 + \frac{R_f}{R_q}\right)V_p - \frac{R_f}{R_q}V_q$$

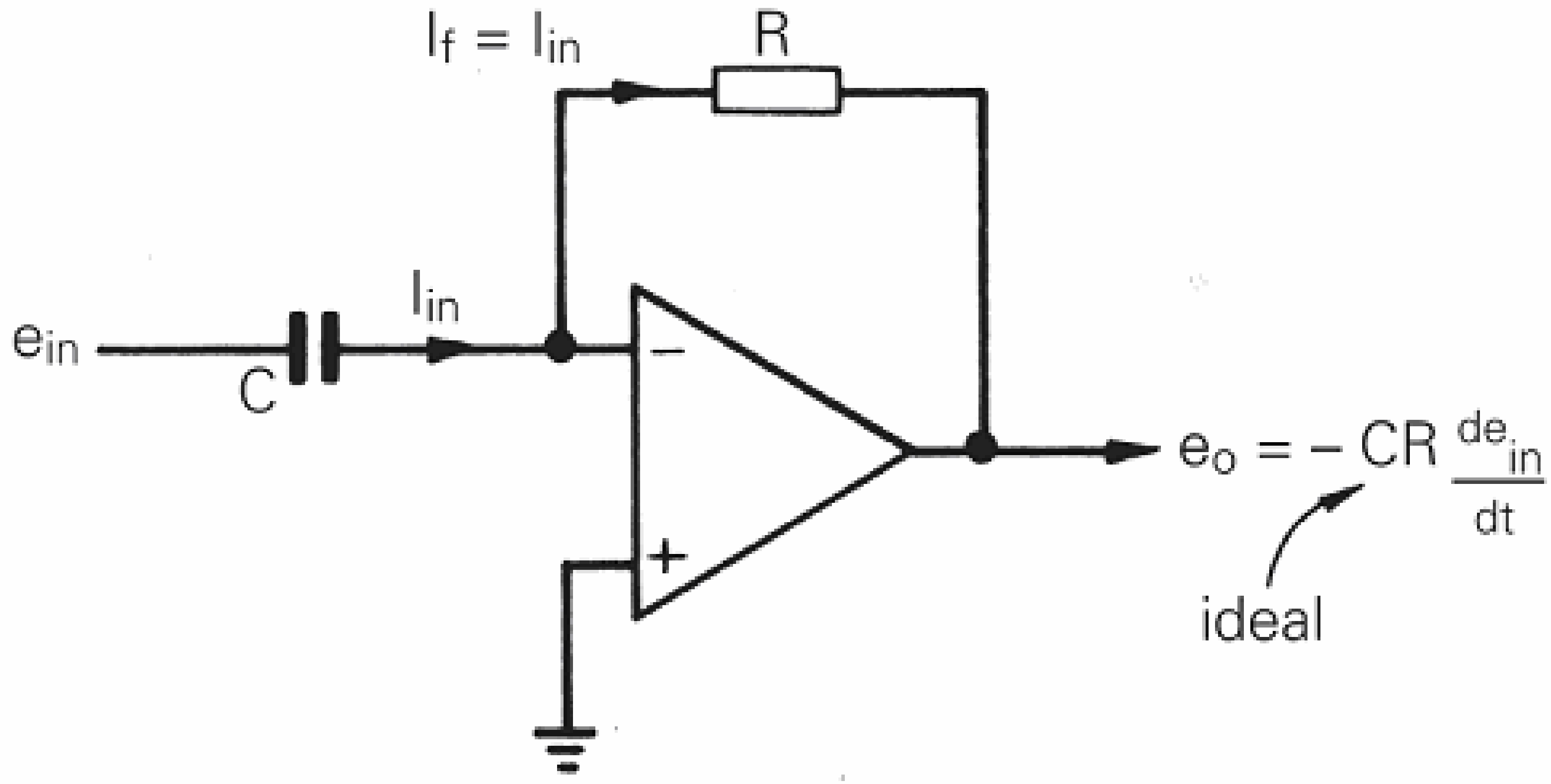
For: $R_f = R_q$, $R_p = R_g$

$V_r = V_p - V_q$

Integrator



Differentiator

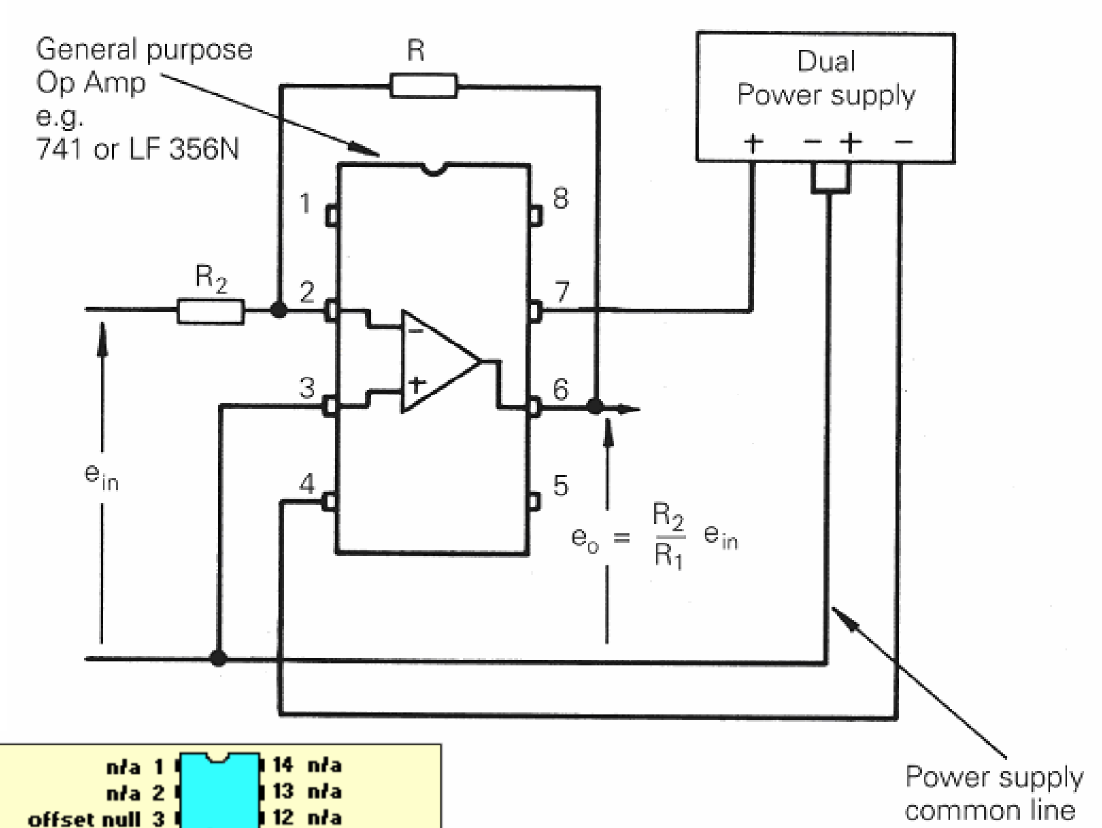


Limitations of the Ideal Op-Amp Concept

Real op-amps have characteristics that approach those of an ideal op-amp, but do not quite attain them:

1. **They have an open-loop gain, which is very large (in the region of 10^6) but not infinite.**
2. **They have a large, but finite, input impedance.**
3. **They draw small currents at their input terminals (bias currents).**
4. **They require a small differential input voltage to give zero output voltage (the input offset voltage). T**
5. **They do not completely reject common mode signals (finite common mode rejection ratio, or CMRR). Common mode rejection describes the ability of the amplifier to reject equal-magnitude signals that appear on both of its inputs.**

Op-amp Packages



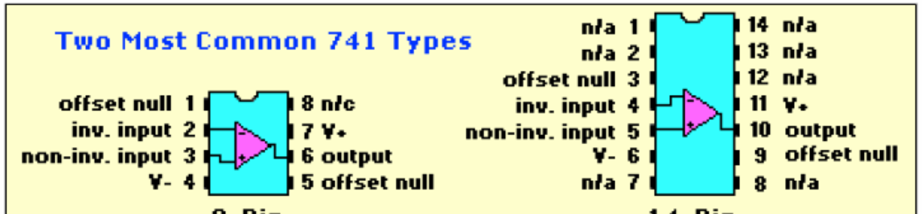


Fig. 6


Thank You!